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EDINBURGH; or from THE METEOROLOGICAL OFFICE, SOUTH KENSINGTON, LONDON, S.W. 7.

The Line Squall of November 26th, 1922.

BY E. G. BILHAM, B.Sc.

DURING Sunday, November 26th, the passage of a disturbance of the line-squall type was reported from several of the observing stations. The following particulars were received at the time by telegraph :—

Eskdalemuir.—Squall at 8h. 30m.; temperature fell 9°F. wind changed from NW to N.

Cranwell.—Line squall passed 11h. 45m.

Croydon.—Line squall 15h. 20m.; temperature fell 6°F.; barometer rose 1½mb.; wind veered 6 points; extreme force 5; gust of 33 m.p.h., heavy rain showers.

Biggin Hill.—Line squall 15h. 20m.; temperature fell 6°F.; barometer rose 1½mb.; wind veered 6 points; extreme force 7; heavy rain showers.

According to a detailed report from Eskdalemuir, the passage of the "cold front" was not marked by strong wind. The wind speed shown by the anemometer was only 20 miles per hour and there was no noteworthy gust at the time, though there had been gusts of 40 miles per hour between 6h. and 7h. The increase of pressure, about 0·6 mb. and the change of wind direction took place between 8h. 30m. and 8h. 35m. During these five minutes temperature fell barely half a degree, but a rapid fall, 8·5°F. in 12 minutes, followed. Rain commenced at

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8h. 35m. and continued until 9h. 50m. The amount of rain was 1·9 mm., of which 1·7 mm. fell between 8h. 35m. and 9h. 15m.

At the Meteorological Office, Kingsway, the Dines float-barograph showed that pressure decreased steadily at the rate of 0·9mb. per hour until 14h. and remained nearly steady until 14h. 30m. It then rose about 1·3mb. in 2 or 3 minutes and subsequently rose pretty steadily at the rate of 0·8 mb. per hour.

An examination of the synoptic charts shows that a very marked line of discontinuity travelled across the British Isles, approximately from north to south, during the day. The line formed the eastern boundary of a wedge-shaped mass of warm air, with colder air on all sides except the west. Following Bjerknes we will call the northern boundary of the wedge the "cold front" and the southern boundary the "warm front." The phenomena we are interested in occurred as the cold front passed the successive stations.

Fig. 1 reproduces the synoptic chart for 13h. on November 26th, a pecked line indicating the position of the discontinuity. Isobars are drawn at intervals of 2mb. To account for the observed increases of pressure it is necessary to introduce the abrupt discontinuities shown in the isobars. From the fact that Eskdalemuir only experienced half the sudden change observed near London we must conclude that the magnitude of the isobaric discontinuity decreased rapidly towards the west.

Prof. Bjerknes's "polar front" theory involves the assumption that polar air and equatorial air owe their characteristic properties primarily to their source of origin. We should expect to find, therefore, that the warm and cold air on November 26th came from widely different regions. That this was really the case is clear from the trajectories of the air arriving at 13h. at Eskdalemuir (in the cold region) and at London (in the warm region) shown by the full lines in Fig. 2. The cold air had come straight from high northern latitudes, while the warm current can be traced back to an anticyclonic area of indefinite winds which was off our south-west coasts two days earlier. Its previous history is not very clear, but its anticyclonic origin and slow journey over comparatively warm sea probably sufficed to give it the requisite equatorial properties.

The abrupt rise of pressure which accompanied the passage of the cold air shows that the surface of separation must have sloped steeply upwards to a considerable height. This would result in the replacement of a large mass of warm air by the colder and denser air in the course of a minute or two. The depth of the "nose" of polar air concerned in the abrupt rise may be calculated on the assumption that the change of temperature throughout the layer was the same as that measured

at the surface. The calculation gives 850 feet for the depth at Eskdalemuir, and 3,300 feet at Croydon. Allowing for the

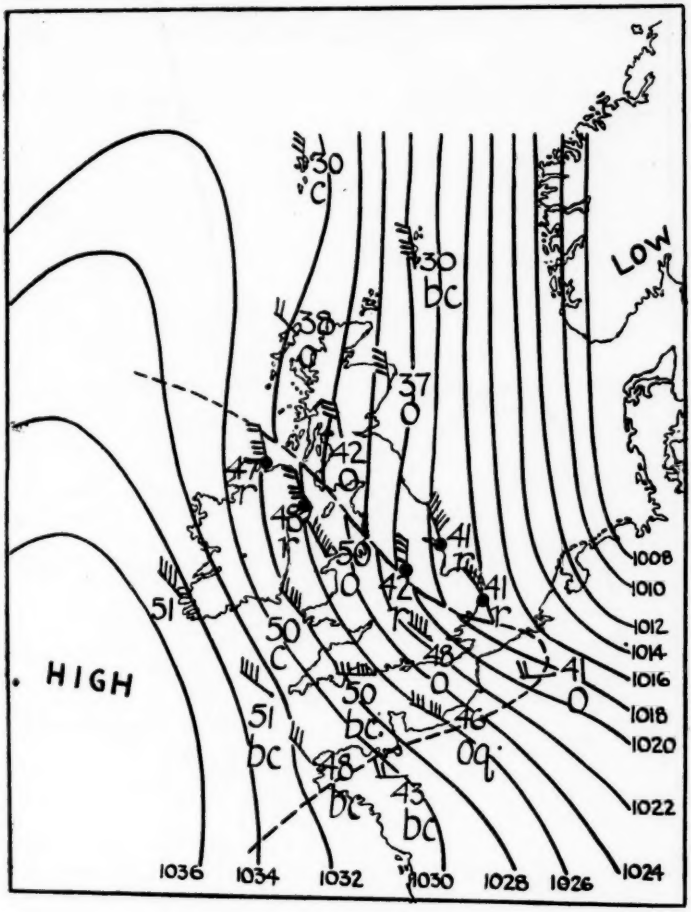

FIG. 1.—Isochronous Chart, 13 h. on Nov. 26th, 1922.

fact that Eskdalemuir is 700 feet above sea level and Croydon only 245 feet, the "nose" appears to have been more than

twice as deep at Croydon as at the Scottish station. An aeroplane observation at Leuchars, Fifeshire, at 10h. showed that the

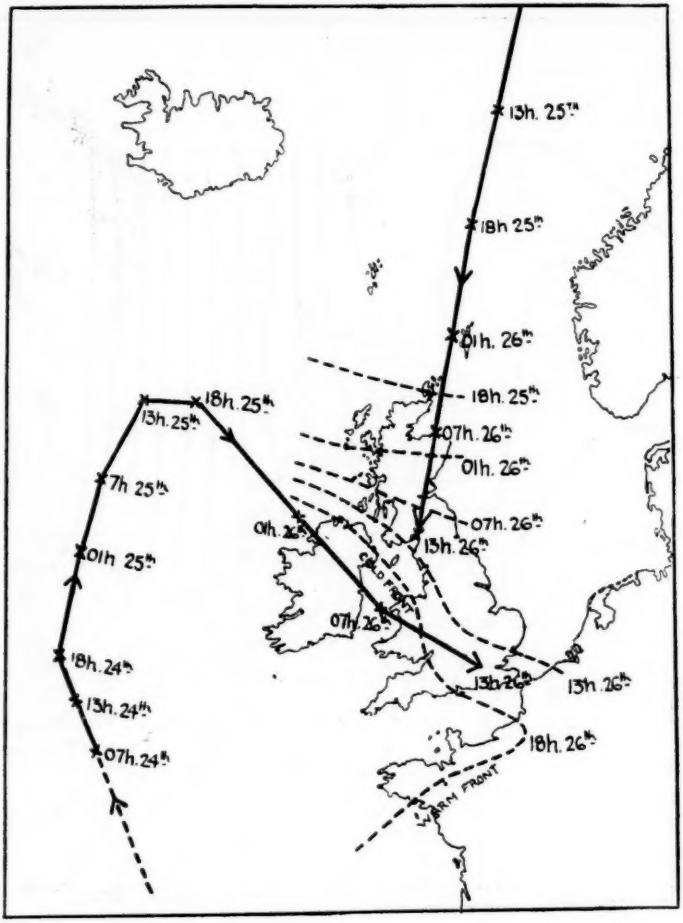

FIG. 2.—Chart showing movements of the cold front and trajectories of the air, Nov. 24th–26th, 1922.

air was cold up to the top of the ascent (6,380 feet); Leuchars was then over a hundred miles behind the cold front, and the

polar air probably occupied a depth considerably exceeding 6,000 feet. If the ascent had been high enough to reach the surface of discontinuity, its average slope could have been determined with considerable accuracy.

Fig. 2 shows the position of the cold front at the fundamental observation hours between 18h. November 25th and 18h. November 26th. For the latter hour the warm front is shown as well. The rate of propagation was very irregular, but it was obviously least in the west, where the smallest barometric gradients were found. Between 13h. and 18h. on the 26th, the rate of movement over south-east England was 22 miles per hour towards south-south-west.

It will be seen from Fig. 1 that in this region the gradient wind in front of the squall was inclined about 30°, while the gradient wind behind the squall was inclined about 60° to the cold front. Computing the gradient winds and resolving at right angles to the cold front, we obtain the following results :—

Component of preceding wind in direction of propagation = 25 m.p.h.

Component of following wind in direction of propagation = 26 m.p.h.

These values are in good agreement with the values found for the rate of advance, and imply that there was little horizontal transfer of air across the boundary. That is to say, the system was at that time advancing as a whole without any gain by the polar air at the expense of the equatorial. Under these circumstances there could have been no very violent ascensional movements due to the undercutting of equatorial by polar air, and we would therefore expect little rain. Actually none of the stations in south-east England registered more than a millimetre between 7h. and 18h. on the 26th, though larger falls occurred on the East Anglian coast. It may be remarked, however, that the warm air was comparatively dry and the adiabatic cooling due to a rise of 3,300 feet would have produced only about 1 mm. of rain. The heavier falls on the coast may have been due to the reinforcing of the relatively feeble ascending currents, after the manner recently described* by J. S. Dines.

After 18h. on November 26th, the cold front moved very slowly south-westward and became difficult to identify. In the extreme south-west corner of England the temperature never fell much below 50°F. On the 28th warm air from the west spread over the British Isles again, the temperature rising to above 50°F. in nearly all districts by 13h. on that day.

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* *Q. J. Roy. Met. Soc.* Oct. 1922.

The Rainfall of 1922.

THE few days which elapse between the end of each year and the date when the January number of *The Meteorological Magazine* goes to the printer suffice for only a very hurried scrutiny of the rainfall records for the year.

Several thousand returns have already been received, and from these have been selected only those for which average values are available in order to enable a preliminary idea to be obtained of the relation of the year's fall to the normal. At the moment of writing 280 such records have been examined. It is unfortunately apparent, even at this early date, that the amount of information available for Ireland will be less than usual. A number of extremely valuable old records, long utilized as standards of reference for Irish districts, have come to an end on account of the disturbed conditions. In other parts of the British Isles the data already received are sufficient to yield a fair basis for the construction of a rainfall map.

Dealing first with the rainfall of the individual months of 1922, the following summary shows that the rainfall over the country as a whole was close to or above the average except

Monthly General Rainfall as Percentage of Average.

1922.	England and Wales.	Scotland.	Ireland.	British Isles.
January	158	131	126	141
February	148	124	138	138
March	103	76	72	87
April	155	126	136	141
May	57	129	69	83
June	64	102	69	77
July	172	113	112	139
August	132	78	104	109
September	128	87	117	110
October	33	59	37	42
November	55	70	42	56
December	122	86	102	105

in the autumn. Fear began to be felt in parts of England lest the slight local deficiency of rain in May and June might herald a resumption of the drought of the previous summer, but excessive rains in July showed these fears to have been groundless.

During July the total fall was excessive everywhere except in the west of Scotland, whilst locally in England more than twice the average fell. Somewhat similar conditions recurred in August, when great cyclonic rains gave abnormally large totals in the English Midlands. The autumn generally was dry, especially October, when less than a quarter of the average fell in an area stretching from Lancashire to Sussex and including

nearly the whole of Wales. The weather conditions during September and October were of the easterly type giving patches of relatively high rainfall on the east coast, but during November and early December the pressure conditions were not unlike those of the summer of 1921, and the fear of a resumption of the drought was probably better justified than at any other time. In December, however, normal winter conditions returned with numerous depressions and excessive rainfall in most parts of England and Ireland.

The most notable feature in the rainfall of the whole year was a belt of excessive fall extending, with some interruptions, from Devonshire and Hampshire northward through the Midlands to Newcastle-on-Tyne. In this tract excesses of 20 per cent. were experienced on Dartmoor, in northern Hampshire, Leicestershire, Nottinghamshire and part of Yorkshire. Another patch of similarly high fall occurred in Norfolk. Except in North Wales, where one or two stations had more than the average, Wales and the west of England, north of the Bristol Channel, had a deficient rainfall. On the east of the central wet belt in England there was slightly less than the average on part of a narrow coastal strip, particularly in the south-east.

In Scotland the conditions were the reverse of those in England. There was a relatively dry belt in the interior with a deficiency of more than 10 per cent., whilst both the east and west coasts showed a tendency to excess, in no case very pronounced.

Of the distribution in Ireland it is difficult to speak with any certainty. There appears to have been an excess in the north and centre, but nearly everywhere else rather less than the normal fell. The most conspicuous deficiency was in a strip extending from Cork to Greenore, culminating in deficiencies of nearly 20 per cent. in the neighbourhood of Dublin.

The general rainfall of the countries as provisionally computed was as follows :—

England	106	Scotland	97
Wales	97	Ireland	94
England and Wales ...	104	British Isles	100

The local wet areas were thus counterbalanced by the larger areas of slight deficiency, the country as a whole having practically the normal fall for the year.

A Summary of the Weather of 1922.

A USEFUL bulletin was issued by the Forecast Division of the Meteorological Office on December 31st, 1922. It consists of two sheets, one a concise account of the weather of 1922, the other a summary of records of temperature, sunshine and rainfall for the year, somewhat on the lines of the Monthly *Supplement to the Daily Weather Report*. The values given are those from a chain of eight stations, stretching from Aberdeen to Falmouth.

The newspapers showed their appreciation of this innovation.

Meteorology at the Science Museum, South Kensington.

THE Board of Education has recently published a catalogue* of the meteorological collection in the Science Museum, South Kensington. The 279 exhibits in the Museum are grouped under appropriate classes and a historical introduction is given for each class. In addition, each exhibit is fully described, and bibliographical references are added where possible. Photographs of a few of the exhibits are also included.

The catalogue is a valuable contribution to meteorology. It is useful to all who study the subject, whether used as a guide to the exhibits or as an independent publication. The comprehensiveness of the catalogue may be gauged from the fact that there are thirty-eight exhibits in the anemometer class, thirty-four in the thermometer class, and that twenty-four patterns of rain-gauge are described.

The historical introductions are worthy of special mention. In the introduction to thermometers it is noted that so long ago as the third century B.C. physicists knew that some relation existed between the temperature and volume of a mass of air, and that descriptions of apparatus which represent the primitive idea of the thermoscope are to be found in writings of that time. There appears to be no mention of the thermometer in literature again until Galileo Galilei wrote some 1,800 years later.

The Tower of the Winds at Athens is mentioned as the earliest known device for locating wind direction. The first weather-cock was fitted to a church in the Tyrol in the year 820 A.D. The first mention of an anemometer dates back to 1667, in which year a pressure-plate anemometer of the pendulum type was described in a Royal Society publication. The instrument had been in use some time at that date.

The history of rain-gauges dates back to 1442 when, according to the ancient records of Korea, bronze instruments were constructed. The following extract from the introductory history to rain-gauges gives some indication of the scope of the publication:—

> "In this country the earliest scientific instrument for indicating the rainfall was devised by Sir Christopher Wren about 1662, and was fitted with a tipping bucket, which served as a record. Previously, no special instrument for the local measurement of rainfall had been produced, and the only available evidence was dependent on direct inference, such, for example, as the flood marks of valleys.
>
> "The first records of rainfall were made in Paris by

* *Board of Education, Catalogue of the Collections in the Science Museum, South Kensington, with descriptive and historical notes and illustrations.* METEOROLOGY, 9½ × 6, pp. 108, illus. H.M.S.O., 1922. Price 1s. 6d. net.

Perrault in 1668, and the first in this country by Townley nine years later. Townley's gauge consisted of a funnel of 12 in. diameter, soldered to a leaden pipe through which the water flowed into convenient vessels, and was weighed. Great care was taken to ensure that the funnel was firmly fixed, and that no rain could trickle down the outside of the funnel into the receiver. The next gauge of which details are available was designed by Hooke and used at Gresham College in 1695. It consisted of a glass funnel of 11·4 in. diameter, mounted on a wooden frame, and leading into a large flask capable of holding about 2 gallons and being provided with a long and narrow neck to minimise evaporation.

"With this apparatus also the collected water was weighed. . . . Two years later Derham, at Upminster, employed a gauge which was similar in principle to Townley's and similarly mounted. As early as 1722 a close approach was made to the modern principle by Horsley in Northumberland, who used a large funnel 30 in. in diameter and 10 in. deep, while a similar apparatus was employed by Abbot Didacus de Revillas at Rome in 1742."

In the introduction to the exhibits classified under "Weather" a concise history of the development of meteorology is given. The history commences with the earliest known journal, kept at Oxford by Rev. William Merle from 1337 to 1344, and concludes with a sketch of the growth of the *Daily Weather Report* up to 1911.

Among the thermometers are a Royal Society's standard thermometer dating from about the latter part of the eighteenth century and a photograph representing five old thermometers by Micheli du Crest, 1754. The thermometer designed for use on aeroplanes brings the thermometer class up to date.

Among the barometers a very fine example of a Diagonal Barometer is shown. "The instrument, which dates from about 1750, is of the type designed by Sir Samuel Morland. In order to obtain an open scale the upper portion of the tube is inclined considerably to the vertical and any change in the barometric pressure is accompanied by a much greater motion of the mercury along the tube than in the case when the barometer tube is vertical.

Mounted on the same board is an alcohol thermometer graduated according to the Fahrenheit scale.

The intervening space is occupied by a calendar entitled "A Perpetual Regulation of Time," from which the days of the month, zodiacal signs, sun's right ascension, declination, and time of rising and setting, high water at London Bridge, and phases of the moon can be ascertained."

Sunshine recorders range from the first spherical lens made by Mr. Campbell, of Islay, for sunshine recording (1857) to Angstrom's compensated pyrheliometer and Callendar's sunshine receiver, both made by the Cambridge Scientific Instrument Company.

A collection of cloud photographs by Mr. G. A. Clarke illustrates the different types of clouds. Cloud photographs taken from the air by Captain C. K. M. Douglas, R.A.F., give a general indication of the appearance of the types of cloud when viewed from above. The cloud section includes nephoscopes, and allied instruments such as the Darwin-Hill position-finder. The section devoted to "The Atmosphere and its Circulation" contains the anemoidograph designed by Sir Napier Shaw and Sir Horace Darwin for tracing the path of air moving with a definite angular deviation from circular isobars, and a zoetrope arranged by Sir Napier Shaw to illustrate the passage of depressions and the motion of the air.

With reference to the collection itself, it seems unfortunate that the instruments are so arranged that there is no obvious distinction between modern instruments and those of purely historic interest. It is understood that the collection will shortly be moved to the new galleries and it is hoped that advantage will be taken of the opportunity to effect an improvement in the arrangement. At the same time the exhibits will be brought nearer to the Meteorological Office so that they will serve to supplement the display in the Office Library.

M. T. S.

OFFICIAL NOTICES.

Winter Thunderstorms.

CAPTAIN C. J. P. CAVE proposes to continue, in collaboration with the Meteorological Office, the investigation of winter thunderstorms which he has carried out during recent years, and the Director of the Meteorological Office will be much obliged if observers would kindly send to the address given below particulars of any thunder or lightning they may observe from January 1st to March 31st. Captain Cave would be glad to know—

1. Date and time of storm; direction in which it was observed; whether thunder only, lightning only, or both; how long the storm lasted.
2. Whether the storm was severe, or whether there were only one or two claps of thunder, and one or two flashes of lightning.
3. The time when the storm passed overhead, if it did so.
4. Whether there was rain, hail, or snow.
5. If there was much or little wind, and direction of same.
6. In the case of lightning only, seen at night, a particular note of the direction in which it appeared.

Observers may not have the opportunity of noticing all the above particulars, but *any note of the occurrence of thunder or lightning, with any particulars the observer may think worth notice will be extremely useful.*

Notes should be sent by postcard or letter to Capt. C. J. P. Cave, Stoner Hill, Petersfield, and *not* to the Meteorological Office.

Discussions at the Meteorological Office.

December 11th, 1922. *Über den Aufbau hoher Antizyklonen und Zyklonen in Europa.* By F. M. Exner (Met. Zs., Oct., 1921. Transl. in U.S. Monthly Weather Review, Dec., 1921, pp. 653–655).

Opener—Major G. M. Dobson.

The basis of Exner's paper is the work of A. Schedler* in which upper air observations have been classified so as to give the means of pressure and temperature at various heights corresponding with specified pressures at sea level, the cases of rising and falling barometer being distinguished. Exner gives a striking diagram which may be regarded as a cross section through a cyclone and an anticyclone (though, as Sir Napier Shaw mentioned in the discussion, this interpretation must be accepted with caution). It appears that at middle heights the lowest pressure is further east than at the surface, whilst the lowest temperature is further west. At the base of the stratosphere symmetry is restored.

The paper throws some light on the significance of the well-known correlations obtained by Mr. W. H. Dines. Mr. Dines, himself, attaches great weight to the absence of correlation between wind direction and temperature in the upper atmosphere. It is difficult to reconcile the symmetry on which Mr. Dines insists with the asymmetry of Exner's diagram. Major Dobson suggested that in Mr. Dines's work the characteristics of the layers just below the stratosphere predominated, whereas most recent studies had been concerned primarily with the currents at a few thousand feet.

It is clear that there is a great need for sets of simultaneous upper air observations from a close network of stations, and that the observations should extend to the stratosphere. The resulting detailed charts promise to be much more helpful in giving clear ideas of the processes at work than mere statistical investigations.

The subject for discussion on February 5th, 1923, will be a paper on *Cloud Formation* by Dr. C. Braak (K. Mag. en Met. Obs; Verh. No. 10. Batavia, 1922). The discussion will be opened by Dr. J. S. Owens.

* *Die Beziehungen zwischen Druck und Temperatur in der freien Atmosphäre.* (Beitr. z. Phys. d. fr. Atm. Bd. 9, Heft. 4).

The Royal Meteorological Society.

THE usual monthly meeting of the Society was held on Wednesday, December 20th, Dr. C. Chree, President, in the chair.

C. J. P. Cave, M.A., and R. A. Watson Watt, B.Sc., F.Inst.P. —The study of radio-telegraphic atmospherics in relation to meteorology.

Atmospherics are electro-magnetic waves of low frequency, which manifest themselves in radio-telegraphic receivers as disturbing noises. They are, therefore, a serious hindrance to wireless telegraphy, but they are of great interest to the meteorologist, and were studied many years before commercial radio-telegraphy was practicable. As far back as 1898 it was observed that the approach of a thunderstorm was indicated by atmospherics several hours in advance of the arrival of the more familiar meteorological signs. Later observers found that atmospherics were associated with low pressure, high wind, heavy rainfall, and rapid fluctuations of pressure and temperature. In 1915 radio-telegraphic direction-finding was introduced at South Farnborough, primarily with a view to the issue to aircraft of warnings of approaching line-squalls and thunderstorms. During the years 1916–1920, some twelve of the Coastal Direction-finding Stations of the Admiralty reported "intensity and bearing of atmospherics" at frequent intervals during the day and the reports were collated at South Farnborough. The intersections of bearings greatly helped in the recognition of storms. This method of thunderstorm location has proved very successful, and has been tested over a range of from 5 to 1,000 miles.

In their paper Messrs. Cave and Watt restricted themselves rather scrupulously to the question of the location of thunderstorms by electric waves; the discussion covered a wider range. As was pointed out by Dr. Simpson, there are many ways in which weather conditions affect the transmission of artificial electric waves. The explanation of these effects is of interest to the "wireless" expert; it may prove to be of greater importance to the meteorologist. As to "atmospherics," whilst many are due to lightning and others seem to be associated with "warm front" rain, there is another class which is highly localised and which has not been correlated with meteorological conditions. Captain Slee cited the curious case of Gibraltar, where the reception of wireless messages is generally difficult. It was stated that atmospherics occasionally made communication between ships in the Mediterranean impossible, though

the messages which were unintelligible at short range could be picked up in England.

The experimental station at South Farnborough is now maintained by the Radio Research Board, and Mr. Watson Watt, who is still stationed there, is devoting his time to the extension of these important investigations.

C. J. P. Cave, M.A.—Winter thunderstorms in the British Islands.

The results of an investigation into the frequency of winter thunderstorms, carried out by Captain Cave during the first three months of the year in 1916, 1917, 1918 and 1920, are summarized in this paper. Storms occurred somewhere in the British Isles on over 40 per cent. of the days in question, and some of the storms were very widespread. Captain Cave suggested four causes of instability which may result in thunderstorms, (1) the heating of the lower layers of the atmosphere, (2) the cooling of the upper layers, (3) the rising of a warm current over a cold one, and (4) the undercutting of warm air by cold air. He concluded that this last condition, which favours the close proximity in the lower atmosphere of air currents of widely different temperatures, is an important factor in the causation of winter thunderstorms, and that most of the storms in the period examined occurred under such conditions.

An interesting contribution to the discussion of this paper was a letter from Mr. Newnham, who maintained that the differences of temperature in the air currents near the earth's surface, as shown on Captain Cave's maps, were comparatively unimportant and that the principal cause of winter thunderstorms was the warming from below of a current which had come from the polar regions, and passed for great distances over the comparatively warm ocean. In this connection Mr. Brooks mentioned that winter thunderstorms were far more frequent near the west coast of Denmark than further east, evidence which implies that the instability produced over the sea is quickly removed as the air flows over the colder land.

Captain Cave is collecting observations again this winter, and the new information should throw more light on these controversial questions.

D. E. Row—Forecasting Sky-types.

Mr. Row has found that meteorology may be of great service to the artist. Some account of his experience was published in *The Meteorological Magazine* for March 1922. Further details of the methods he uses were described in this paper, and the sketches which were exhibited showed the success he has attained in forecasting sky-types.

Correspondence.

To the Editors, *The Meteorological Magazine.*

Nature Study.

PHENOLOGY is that branch of meteorology which studies the effect of weather conditions upon the seasonal development of animal and plant life. From the late 'seventies, and since 1891, on an uniform systematic plan, the Royal Meteorological Society has issued an annual report on phenology. This report, by collating and co-ordinating the work of a number of observers, mostly amateurs, in the British Isles, is able to present in summary form, supplemented by tables and maps, information of a most valuable botanical, ornithological, and agricultural nature. All that observers are required to do is to note carefully the first appearance of certain birds and insects, twelve in number, and the first blooming of fourteen common plants. Other migrants and notes are asked for, but these are of secondary importance.

Here is a work which should surely appeal to the Nature-lover. By simply recording a few observations on a prescribed form, and forwarding the same promptly about November 15th (the close of the phenological year) to the office of the Society, 49, Cromwell Road, S.W. 7, the work of the amateur is lifted from a purely local value to become a real link in the progress of scientific research.

Stations are still urgently needed in many parts of our islands, and a copy of the observing form will be forwarded upon application to the office of the Society, or to either of the following :—

J. E. CLARK, B.Sc.

41, *Downscourt Road, Purley, Surrey.*

I. D. MARGARY, M.A.

Chartham Park, East Grinstead, Sussex.

Ball Lightning.

(From *The Times*, December 23rd, 1922.)

THERE was in this locality on December 18th, between 6 and 8 p.m., an extraordinary display of the so-called ball lightning. The phenomenon took the form of balls of bluish, misty flame, which either hovered stationary or darted about the heavens in a curiously irregular manner. Vivid lightning of the ordinary kind accompanied the display, which must have lasted at least two hours. As a close observer of the sky for over fifty years, I have never before witnessed such a spectacle.

LIONEL SMITH-GORDON.

Alderholt Lodge, near Salisbury.

An Observation of Mammato-Cumulus.

A GOOD example of the somewhat rare type of cloud known as mammato-cumulus was to be seen here to-day, December 19th, 1922.

The surface wind was from the south-west, and the cloud under observation was moving slowly from the same direction, its edges sharply defined against the dull sky, except where they merged into trailing curtains of falling rain that mingled with the waters of the Channel. The underside of the massive cloud-bank was heavily festooned with overlapping, balloon-like masses of inky vapour, bulging downwards over the wintry sea. It was a striking sight; threatening and sinister. Very little rain fell inland and the bulging appearance did not last long, gradually fading away into a uniform expanse of slaty-grey. This cloud is often associated with thunderstorms; but, so far as I am aware, such was not the case in the present instance.

ARTHUR BUTCHER.

31, *Beach Street, Deal, December 19th*, 1922.

The Design of Rain-Gauges.

I AM sorry to find my note on the design of rain-gauges, as printed in the December magazine, has by some means been made to say exactly the opposite of what I meant.

I have not my draft at hand, but my intention was to say the high rim of Snowdon or Meteorological Office pattern invariably gives a *lesser* not a larger total for the year.

With 100 more square inches of receiving surface to be wetted there is double the loss of water with the high rim. That may only amount to ·002 in. per day, but with 200 days rain there would be a difference of ·4 in. in addition to the loss in dew. This is not far from what I have found.

J. ELLIS MACE.

View Tower, Tenterden, January 1923.

[It is much regretted that the substitution of "larger" for "lesser" in the printer's copy of Mr. Mace's letter of October 19th was overlooked.—ED. *M.M.*]

An Exceptional Mirage.

An account of a remarkable mirage seen at the Cape Wrath Lighthouse on December 5th, 1922, has been received at the Meteorological Office. The mirage "consisted of the land and sea extending from Dunnet Head to Cape Wrath reflected right across the heavens in a southerly direction . . . . . The mirage appeared precisely as if one was at sea some ten miles off and looking inwards at the original."

NOTES AND QUERIES.

Sleet: A Word with many Meanings.

THE growth of language by the alternate generalization and specialization in the meaning of words is very interesting to the philologist but may be very disconcerting to the workers in other branches of science. An English meteorologist, reading in Humphreys's book on the *Physics of the Air* the following definition of sleet " ice pellets, mere frozen drops (or largely melted snow flakes refrozen)—frozen during the fall of the precipitation through a cold layer of air near the surface of the earth—that rattle when they strike a window, for instance " will not be inclined to accept it without a protest. In fact some discussion of the difference of practice on the two sides of the Atlantic is needed. Fortunately, the Americans have laid their cards on the table, for in the year 1916 the Chief of the Weather Bureau at Washington appointed a Committee " to formulate suggestions of an appropriate nomenclature of sleet " and a lengthy summary of the report of this Committee is printed in the *Monthly Weather Review*.*

The Committee found that the word sleet was used with four distinct meanings in America :—

(*a*) Rain and snow together.
(*b*) " Soft hail " or " graupel."
(*c*) Small particles of clear ice (frozen rain).
(*d*) A coating of ice deposited on twigs, wires, etc.

It was the growth of the popular use of the word sleet in the last of these senses that had made the question urgent, since the havoc due to the weighing down of telegraph wires by ice is a matter of great importance in the United States. The Committee found that this use of the word sleet was generally admitted to be of recent growth and recommended the substitution of " glaze " as the more appropriate term. " Glaze " was preferred to " glazed-frost " (the name adopted officially in this country), since " frost " suggested to many the irregular shapes and the whiteness of hoar-frost rather than the mere presence of frozen water.

It is admitted by the Committee that our use of " sleet " for rain and snow together is in accordance with the earliest English meaning. They give quotations from Murray's Dictionary which take the verb " to sleet " back to 1325, and the noun to 1635 : (" We have sometimes sleet ; which is snow and rain together ").

It appears that this usage is not uncommon in America even

* May 1916, Vol. 44, p. 281.

at the present day, but it has never been adopted there in the official instructions to observers. At any rate from 1850 to 1882, the instructions made sleet the name for graupel. At some date between 1882 and 1897, there was a change in practice and from the latter date the rule has been "only the precipitation that occurs in the form of frozen or partly frozen rain should be called sleet."

The Committee concluded by recommending the maintenance of this last definition and slurred over the fact that they were thereby making permanent a divergence from the practice in this country. Their attention does not seem to have been called to the fact that the word was to be found, used in the English sense, in the report of the International Meteorological Committee (Rome, 1913), though not incorporated in a formal resolution.

There is undoubtedly a need for a name for the frozen raindrops which the Weather Bureau calls sleet; they are not the same as graupel, for graupel is white and crumbles between the fingers and differs from the pellets of clear ice under consideration. The German name for these pellets is Eiskörner. Hellmann writes,*—"Eiskörner consist of glass-hard transparent spherules of ice that fall during the cold half of the year. The spherules strike the ground hard like bird-shot, rebound elastically and when they strike the dry foliage make a rather loud noise that at once attracts attention. Often the ice pellets are not round but rather angular or pointed." For such pellets an appropriate name† would be ice-shot. As a suitable symbol, sufficiently like those for hail ▲ and graupel △, we may suggest a triangle with a dot inside it ◬ which is easy to write or to print.

Since 1916, when the Weather Bureau Committee reported, the British use of the word sleet has been accepted by the International Meteorological Conference of 1919 in Paris in the adoption of a special symbol for it and no official protest seems to have been made by those who prefer the American usage.

The same meteorological conference of 1919 took steps, however, towards the publication of an international glossary of meteorological terms and it may be hoped that the question will be cleared up eventually. F. J. W. W.

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* *The Classification of the Hydrometeors.* Trans. in *M. W. Review*, July 1916, Vol. 44, p. 385. Jan. 1917, Vol. 45, p. 13.

† The following note appears in the *Codex of Resolutions adopted at International Meetings, 1872–1907*, by Hildebrandsson and Hellmann (English Edition, M.O. 200, p. 24; German Edition, p. 18):—

"Small particles of clear ice which are not similar to graupel, are distinguished by the name of 'ice rain' [Eisregen]; a symbol has not been agreed on for this by no means rare phenomenon. As far as the authors know, International Conferences have not, as yet, discussed this point."

Radiation from the Sky.

In the table printed below the means of the various determinations of radiation at Benson during 1922 are set out.

Comparison with the corresponding table for 1921 (*The Met. Mag.*, Jan. 1922, p. 366) shews that the "dark heat" from the atmosphere at the times of the observations was less in 1922 than in 1921 by about 4 per cent. The most striking difference is in the diffuse solar radiation which was lower by over 30 per cent. In May 1921, the value of J_0 was 75, while the highest value for 1922 was 37. In the case of J_1, the maxima for the two years were 250 in June 1921 and 155 in July 1922.

RADIATION MEASURED AT BENSON, OXON, 1922.

Unit: one gramme calorie per square centimetre per day.

		Oct.	Nov.	Dec.	Year.
ATMOSPHERIC RADIATION only (dark heat rays). Averages for Readings about time of Sunset.					
Cloudless days:—					
Number of readings	n	20	15	8	...†
Radiation from sky in zenith	πI	471	448	470	480
Total radiation from sky	J	502	479	500	515
Total radiation from horizontal black surface on earth.	X	701	637	661	702
Net radiation from earth	X—J	199	158	161	187
DIFFUSE SOLAR RADIATION (luminous rays). Averages for Readings between 9 h. and 15 h. G.M.T.					
Cloudless days:—					
Number of readings	n_0	7	6	3	...*
Radiation from sky in zenith	πI_0	23	18	14	25
Total radiation from sky	J_0	38	28	24	34
Cloudy days:—					
Number of readings	n_1	8	7	10	...†
Radiation from sky in zenith	πI_1	105	47	32	90
Total radiation from sky	J_1	89	40	23	76

Unit for I = gramme calorie per day per steradian per square centimetre.

Unit for J and X = gramme calorie per day per square centimetre.

For description of instrument and methods of observation, see *The Meteorological Magazine*, October, 1920, and May, 1921.

† Mean of 12 monthly averages.

* " 11 " " (July missing).

A Correction.

For the values of diffuse solar radiation at Benson on cloudy days in April, May and June (*The Met. Mag.*, Sept. 1922, p. 220), *read* :—

		April.	May.	June.
Cloudy days :—				
Number of readings - -	n_1	8	9	10
Radiation from sky in zenith -	πI_1	102	75	94
Total radiation from sky -	J_1	85	65	83

The Buys Ballot Medal 1923.
Award to Sir Napier Shaw.

It is announced that the Buys Ballot Medal has been awarded by the Royal Academy of Science at Amsterdam to Sir Napier Shaw, F.R.S., Professor in the Royal College of Science, late Director of the Meteorological Office. The medal was founded in 1888 in commemoration of the work of C. H. D. Buys Ballot, the famous meteorologist of the Netherlands, to be awarded every tenth year to the person who is judged to have made the most valuable contributions to the science of meteorology. The award to Sir Napier Shaw is made for his contributions to all branches of the science, and especially for his work as President of the International Meteorological Committee. The previous awards were: 1893, Dr. Julius Hann of Vienna; 1903, Dr. R. Assmann and Dr. A. Berson of Berlin, jointly; 1913, Dr. H. Hergesell of Strasbourg.

Meteorology in the South Orkneys.

In March, 1923, a fine series of observations from the South Orkneys will be available, for that month will complete 20 years of uninterrupted hourly eye-observations. The series will be valuable for the computing of normals and of correlation coefficients. News is also received that the Argentine Minister of Marine has decided to equip a proper Polar ship to effect the annual relief of the staff at the South Orkneys and to carry out explorations and hydrographic work in general.

British Association: Meeting at Hull, 1922.

An account of the discussion on "Weather Cycles in Relation to Agriculture and to Industrial Fluctuations" which was mentioned in this magazine, October, 1922, p. 239, is published in *Nature*, December 30th, 1922, p. 889. The discussion was opened by Sir William Beveridge and continued by Mr. R. A. Fisher, Dr. G. C. Simpson, Mr. Udny Yule and Professor H. H. Turner.

Distributive Stations of the Meteorological Office.

A LIST of the Distributive Stations of the Meteorological Office and their Auxiliary Reporting Stations as at present established is given below.

The Stations at Pulham and Felixstowe were closed on April 10th, 1922,† and that at Collinstown, which had been transferred from Baldonnell on April 28th, 1922, on October 25th, 1922. The Station at Manchester was reopened on a temporary basis on October 25th, 1922.

This list supersedes that given in the Meteorological Magazine, January, 1922, p. 351.

The various types of stations are indicated by the letters in the first column.

Type.	County.	Station.	Lat.		Long.		Height above M.S.L.	Officer in Charge.
			°	′	°	′	Ft.	
R	Fifeshire -	Leuchars - -	56	23	2	52 W.	40	W. Gillon.
C	Renfrewshire	Renfrew - -	55	52	4	24 W.	36	J. J. Somerville.
U	Yorkshire -	Flamborough Head.	54	7	0	5 W.	150	Coastguard.
A	Anglesey -	Holyhead -	53	19	4	37 W.	26	J. D. Ashton.
R	Flintshire -	Shotwick - -	53	13	3	0 W.	16	H. F. Jackson.
C	Lancashire -	Manchester -	53	26	2	15 W.	98	J. A. Watson.
RI	Lincolnshire	Cranwell - -	53	2	0	31 W.	236	W. H. Pick.
R	Devonshire -	Cattewater -	50	22	4	8 W.	82	W. L. Andrew.
R	Hampshire -	Andover - -	51	13	1	31 W.	295	G. H. L. Douglas-Lan
RI	Hampshire -	Calshot - -	50	49	1	17 W.	10	J. Durward.
RR	Hampshire -	South Farnborough.	51	17	0	46 W.	230	R. M. Stanhope.
C	Surrey -	Croydon - -	51	21	0	7 W.	244	G. R. Hay.
U	Kent - -	Biggin Hill -	51	19	0	2 E.	600	D. F. Bowering.
RR	Kent - -	Isle of Grain -	51	27	0	43 E.	20	H. St. G. Dyke-Marsh
C	Kent - -	Lympne -	51	5	1	1 E.	349	R. S. Read.
U	Kent - -	Hythe - -	51	3	1	5 E.	5	Coastguard.
U	Sussex -	Beachy Head -	50	44	0	15 E.	525	Coastguard.
U	Kent - -	North Foreland	51	22	1	27 E.	188	Officer, i/c. P.O. Wireless Station.
U	Kent - -	Deal - -	51	13	1	24 E.	20	Coastguard.

C.—Civil Aerodrome.
R.—Royal Air Force Station.
RI.—Royal Air Force Station (Regular Lectures and Instruction given in Meteorology
RR.—Royal Air Force Station (associated with Research or Design).
A.—Experimental Anemometrical Station.
U.—Auxiliary Observing Station.

† Observations ceased March 31st, 1922.

Reviews.

La Maxima de la Radiacion Solar en Enero y Febrero de 1920 y el Estado del Tiempo Mundial. By H. H. Clayton and Guillermo Hoxmark. 12½ × 10, pp. 16, 9 diagrams. Buenos Aires: Oficina Meteorologica Argentina, 1922.

THIS paper deals with the departures from the normal of pressure, temperature and rainfall over the earth's surface during the months of January and February, 1920, when, as shown by the observations made by the Astrophysical Observatory of the Smithsonian Institution at Calama, Chile, there was a marked maximum in solar radiation. In January, 1920, the mean value of the solar radiation was 1·964 gram calories per square centimetre, which was 1 per cent. greater than in 1919.

For determining the solar influence, two sets of comparisons were made for each of the months under review: the mean values of the principal elements of the climate were compared with those of the same months of the previous year when a normal value of solar radiation was recorded, and were also compared with the normals based on a long series of years.

It was found that the increased solar radiation in January, 1920, was associated with an increase in the normal atmospheric circulation. Barometric pressure was under the average in that part of the earth directly under the sun, *viz.*, from the equator to lat. 30°N and S, while pressure was above the average between lat. 40° and 50° in both hemispheres, with a marked deficiency in the neighbourhood of the Polar circles.

Temperature between lat. 40° N and 40° S, was at the same time slightly under the average, but in high latitudes there was an increase. The influence on the rainfall was difficult to determine on account of local irregularities, but was found to be above the average in the circumpolar low pressure belts between lat. 60° and 70° and also in the tropics, especially from 10° to 30° S, where the sun in January is overhead. On the other hand, there was a diminished rainfall in the high pressure belts between lat. 30° and 50° north and south.

February, 1920, was discussed in a similar way, and it was seen on comparing the results with those of January that there was a progressive movement of the centres of disturbances following solar activity. For example, the pressure centre of greatest excess in North America in January had, in February, moved southward from north-west Canada to the north-western States, and the January zone of deficient pressure near Iceland had moved north-east to Spitsbergen. The deficiency of temperature in Canada had progressed eastward to the east coast of the United States and the western North Atlantic, while

the north-west of the States and Canada had been overspread by a " warm wave." The high January temperature over western Europe had in the succeeding month become even more pronounced and extensive, and now embraced Finland.

It is clearly shown that an increase of solar radiation intensifies the normal pressure distribution, bringing about a more active circulation, so that temperature and rainfall are deficient, especially in middle and high latitudes where winds with a Polar component (of motion) prevail. On the other hand, where winds with an equatorial component were experienced, rainfall and temperature were above the normal. Within the tropics the surface air temperature was found to decrease and the rainfall to increase with the more vigorous atmospheric circulation in higher latitudes. The paper is illustrated by nine diagrams, giving " world " results in graphic form, and a table shows departures from the normal for pressure temperature. and rainfall during January and February, 1920, for 141 stations, the abnormals being grouped in 10° squares in a second table. This paper is an important extension of Mr. Clayton's previous investigations on the effect of short period variations of solar radiation on the Earth's atmosphere.

R.C.M.

Rainfall in the Southern Pennines, Vol. I., No. 10, *Annual Summary, 1919*. By A. A. Barnes, 9 × 10½, pp. 191, 2 maps. Manchester and Stockport Rainfall Organisation, 1922.

We note with pleasure that the useful summaries of rainfall in the Southern Pennines, prepared by Mr. A. A. Barnes for the Manchester and Stockport Rainfall Organisation, are being continued, and trust that the arrears in publication caused by the war will soon be made up.

Although Mr. Barnes deals with the distribution of rainfall more or less on the lines already made familiar in *British Rainfall*, so that the data now presented are in some respects repetitions of those already published, the work is fully justified since its concentration on a particular area enables a great amount of detail to be introduced. The district, which includes about 3,750 square miles, extending from Blackpool to Crewe and from Hoylake to Chesterfield, is in some respects the most important in the country from the point of view of rainfall, since it is the source of the water supplies of practically all the great industrial areas of the north.

The summary before us deals with the year 1919, and is of peculiar interest on account of the fact that the area dealt with happens to include portions both of the English Midlands, for which the year was a very wet one, and of the north-western Pennines, for which it was very dry, so that the range of rainfall was abnormally great.

The Weather of December, 1922.

At the beginning of December an anticyclone was situated over the Bay of Biscay, and this high pressure area maintained its position with little change for the first week or so of the month. During this period westerly winds with mild weather prevailed over the British Isles. There was little rain in the southern districts, but further north, the weather was affected by Atlantic depressions, and there were occasional gales on the coast. A depression in the neighbourhood of the Azores gave 48mm. of rain at Ponta Delgada on the 2nd. On the 7th, a depression over Germany was associated with snow at many places in Germany and Poland, and locally in Denmark. This depression moved away south-eastward, causing unsettled weather with snow and a low temperature over Central Europe, where for some days temperature did not rise above freezing point. On the 8th, further heavy rain fell at the Azores, 42mm. being measured at Horta. By this date the high pressure area to the south and west of the British Isles, stretched from Madeira to Iceland. On the 9th, its central portion covered the British Isles. On the 11th, it was over France and Spain, and it remained over France until the 13th, giving fair quiet weather over south-western Europe.

The Atlantic depressions now began to take a more southerly course, and up to the end of the month the weather of west and north-west Europe was stormy and unsettled. During the latter half of the month, Altantic liners crossing between Europe and America reported gales of an unusually severe and protracted character. A deep depression approached the British Isles and by the evening of the 18th, was centred off the Hebrides. South to south-west gales occurred on the British coasts, and on this day thunderstorms were experienced at various places in the British Isles. In the early hours of the morning of the 20th, an intense secondary depression with a separate circulation appeared at the mouth of the Channel and moved north-eastwards, causing gales and heavy rain over southern England and northern France. At Plymouth, 41mm. of rain fell during the night of the 19th–20th. In the rear of this secondary sleet and snow fell in Scotland and parts of England.

A very large low-pressure area still remained over the Atlantic maintaining very unsettled weather in western Europe. On the morning of the 21st, an exceptionally deep depression, with pressure near its centre as low as 952mb., appeared off the west of Ireland, and as it moved north-eastwards there was a renewal of gales in the British Isles, the English Channel and Scandinavia. A secondary depression associated with it crossed southern England, giving heavy rain and thunderstorms, particularly in the western districts.

On the morning of the 25th, another large depression appeared

(*Continued on p.* 350.)

Rainfall Table for December 1922.

STATION.	COUNTY.	Aver. 1881–1915.	1922.		Per cent. of Av.	Max. in 24 hrs.		No. of Rain Days.
		in.	in.	mm.		in.	Date.	
Camden Square	*London*	2·39	3·14	80	131	·63	21	18
Tenterden (View Tower)	*Kent*	3·11	2·80	71	90	·72	21	17
Arundel (Patching Farm)	*Sussex*	3·36	3·59	91	107	·71	30	13
Fordingbridge (Oaklands)	*Hampshire*	3·96	4·67	119	118	·99	21	18
Oxford (Magdalen College)	*Oxfordshire*	2·32	2·50	63	108	·50	19	15
Wellingborough (Swanspool)	*Northampton*	2·35	2·62	67	111	·56	21	19
Hawkedon Rectory	*Suffolk*	2·42	1·67	42	69	·32	21	16
Norwich (Eaton)	*Norfolk*	2·61	2·68	68	103	·44	23	19
Launceston (Polapit Tamar)	*Devon*	5·12	6·91	175	135	1·57	19	26
Sidmouth (Sidmount)	"	3·93	4·94	126	126	1·19	19	21
Ross (County Observatory)	*Herefordshire*	2·97	4·07	103	137	1·21	19	17
Church Stretton (Wolstaston)	*Shropshire*	3·36	4·57	116	136	1·27	19	22
Boston (Black Sluice)	*Lincoln*	2·15	2·72	69	127	·52	20	21
Worksop (Hodsock Priory)	*Nottingham*	2·36	3·04	77	129	·60	19	19
Mickleover (Clyde House)	*Derbyshire*	2·63	3·78	96	144	·96	19	19
Southport (Hesketh Park)	*Lancashire*	3·23	4·10	104	127	·66	29	23
Wetherby (Ribston Hall)	*York, W. R.*	2·45	4·58	116	187	1·86	20	12
Hull (Pearson Park)	" *E. R.*	2·41	2·26	57	94	·58	20	21
Newcastle (Town Moor)	*North'land*	2·41	3·55	90	147	1·10	20	16
Borrowdale (Seathwaite)	*Cumberland*	16·34	18·45	469	113	..	..	..
Cardiff (Ely Pumping Stn.)	*Glamorgan*	5·11	7·89	200	154	1·50	19	16
Haverfordwest (Gram. Sch.)	*Pembroke*	5·70	5·67	144	99	·84	21	23
Aberystwyth (Gogerddan)	*Cardigan*	5·03	4·79	122	95	·85	14	9
Llandudno	*Carnarvon*	3·10	4·33	110	140	1·22	30	22
Dumfries (Cargen)	*Kirkcudbrt.*	5·41	5·56	141	103	1·09	22	21
Marchmont House	*Berwick*	2·81	2·74	70	98	·56	29	19
Girvan (Pinmore)	*Ayr*	5·99	3·96	101	66	·52	21	23
Glasgow (Queen's Park)	*Renfrew*	4·23	3·11	79	74	·60	25	21
Islay (Eallabus)	*Argyll*	5·93	4·57	116	77	·61	28	26
Mull (Quinish)	"	7·13	7·12	181	100	1·05	22	26
Loch Dhu	*Perth*	10·08	8·90	226	88	1·55	25	23
Dundee (Eastern Necropolis)	*Forfar*	2·66	1·87	47	70	·56	16	19
Braemar (Bank)	*Aberdeen*	3·56	3·56	90	100	·88	22	17
Aberdeen (Cranford)	"	3·48	2·50	63	72	·36	18	18
Gordon Castle	*Moray*	2·69	1·44	37	54	·33	30	12
Fort William (Atholl Bank)	*Inverness*	10·15	9·68	246	95	2·03	12	26
Alness (Ardross Castle)	*Ross*	4·13	3·75	95	91	·59	22	22
Loch Torridon (Bendamph)	"	10·20	10·74	273	105	1·62	12	25
Stornoway	"	6·25	5·88	149	94	·77	5	28
Loch More (Achfary)	*Sutherland*	9·24	9·56	243	103	1·36	5	26
Wick	*Caithness*	3·08	2·38	61	77	·44	23	21
Glanmire (Lota Lodge)	*Cork*	5·50	4·50	114	82	·57	13†	23
Killarney (District Asylum)	*Kerry*	7·28	..	..	..	·97	21	..
Waterford (Brook Lodge)	*Waterford*	4·69	3·61	92	77	·76	15	17
Nenagh (Castle Lough)	*Tipperary*	4·61	6·50	140	119	·77	15	26
Foynes	*Limerick*	4·73	6·21	158	131	·55	16	25
Gorey (Courtown House)	*Wexford*	3·82	2·42	61	63	·43	22	19
Abbey Leix (Blandsfort)	*Queen's Co.*	3·68	4·53	115	123	1·25	15	22
Dublin (FitzWilliam Square)	*Dublin*	2·48	1·81	46	73	·32	13	19
Mullingar (Belvedere)	*Westmeath*	3·68	4·46	113	121	·94	15	24
Crossmolina (Enniscoe)	*Mayo*	6·55	..	..	..	..	..	..
Collooney (Markree Obsy.)	*Sligo*	4·73	5·18	132	109	·94	23	23
Seaforde	*Down*	4·12	4·59	117	111	·75	21	18
Ballymena (Harryville)	*Antrim*	4·44	3·58	91	81	·76	16	24
Omagh (Edenfel)	*Tyrone*	4·23	5·36	136	127	·70	22‡	24
Letterkenny Asylum	*Donegal*	5·35	5·84	148	109	·76	23	24

† *and* 21. ‡ *and* 23.

Supplementary Rainfall, December 1922.

Div.	STATION.	RAIN. in.	RAIN. mm.	Div.	STATION.	RAIN. in.	RAIN. mm.
II.	Ramsgate	2·12	54	XII.	Langholm, Drove Rd.	5·86	149
,,	Sevenoaks, Speldhurst	3·91	99	XIII.	Ettrick Manse	6·80	173
,,	Tottingworth Park...	3·86	98	,,	North Berwick Res. ...	1·63	41
,,	Totland Bay, Aston Ho.	4·41	112	,,	Edinburgh, Royal Ob.	2·68	68
,,	Ashley, Old Manor Ho.	4·15	105	XIV.	Biggar	3·00	76
,,	Grayshott	5·39	137	,,	Leadhills	8·02	204
,,	Ufton Nervet	3·00	76	,,	Kilmarnock, Agric.Coll.	3·56	91
III.	Harrow Weald, Hill Ho.	2·62	67	XV.	Dougarie Lodge	3·27	83
,,	Pitsford, Sedgebrook..	2·60	66	,,	Oban	5·52	140
,,	Chatteris, The Priory.	1·81	46	,,	Inveraray Castle	8·40	213
IV.	Elsenham, Gaunts End	2·07	53	,,	Mull, Benmore	11·40	290
,,	Lexden, Hill House ..	1·77	45	XVI.	Loch Venachar	6·00	152
,,	Aylsham, Rippon Hall	2·69	68	,,	Gleneagles House	4·80	122
,,	Swaffham	2·38	61	,,	Loch Rannoch, Dall...	6·40	163
V.	Devizes, Highclere ...	3·85	98	,,	Blair Atholl	3·98	101
,,	Weymouth	4·54	115	,,	Coupar Angus	2·22	56
,,	Ashburton, Druid Ho.	9·85	250	,,	Montrose Asylum	1·73	44
,,	Cullompton	6·09	155	XVII.	Logie Coldstone, School	2·13	54
,,	Hartland Abbey	5·56	141	,,	Fyvie Castle	1·89	48
,,	Penzance, Morrab Gden.	7·42	188	,,	Grantown-on-Spey ...	1·86	47
,,	St. Austell, Trevarna.	7·97	202	XVIII.	Kingussie, Fasnakyle..	3·47	88
,,	Crewkerne Merefield Ho	5·34	136	,,	Fort Augustus	6·92	176
VI.	Clifton College	5·61	143	,,	Loch Quoich, Loan ...	16·30	414
,,	Ledbury, Underdown.	3·88	99	,,	Faire-na-Squir	6·74	171
,,	Shifnal, Hatton Grange	4·15	105	,,	Skye, Dunvegan	7·47	190
,,	Ashbourne, Mayfield.	4·71	120	,,	Fortrose	1·38	35
,,	Barnt Green, Upwood	3·14	80	,,	Ullapool	4·97	126
,,	Blockley, Upton Wold	4·24	108	XIX.	Dornoch, St. Gilbert's.	1·23	31
VII.	Leicester, Town Hall Sq.	3·12	79	,,	Tongue Manse	3·33	85
,,	Grantham, Saltersford	3·31	84	,,	Melvich Schoolhouse ..	3·01	77
,,	Louth, Westgate	2·94	75	XX.	Castletownshead	5·11	130
,,	Mansfield, West Bank	3·85	98	,,	Dunmanway Rectory..	7·50	191
VIII.	Nantwich, Dorfold Hall	4·95	126	,,	Gearahameen	15·80	401
,,	Bolton, Queen's Park.	6·40	163	,,	Darrynane Abbey	5·69	145
,,	Lancaster, Strathspey.	5·12	130	,,	Cashel, Ballinamona...	4·32	110
IX.	Wath-upon-Dearne...	3·09	79	,,	Roscrea, Timoney Park	4·91	125
,,	Bradford, Lister Park.	3·54	90	,,	Broadford, Hurdlestown	6·70	170
,,	West Witton	5·38	137	XXI.	Kilkenny Castle	3·79	96
,,	Scarborough, Scalby..	3·29	84	,,	Rathnew, Clonmannon	2·54	65
,,	Middlesbro', Albert Pk.	3·48	88	,,	Hacketstown Rectory .	2·96	75
,,	Baldersdale, Hury Res.	5·07	129	,,	Balbriggan, Ardgillan .	2·45	62
X.	Bellingham	4·23	107	,,	Drogheda	2·71	69
,,	Ilderton, Lilburn	3·20	81	,,	Moate, Coolatore	3·76	95
,,	Orton	9·28	236	XXII.	Castle Forbes Gdns....	4·27	109
XI.	Llanfrechfa Grange ..	..	..	,,	Galway, Grammar Sch.	..	..
,,	Treherbert, Tyn-y-waun	13·47	342	XXIII.	Westport House	7·71	196
,,	Carmarthen Friary ..	5·39	137	,,	Aasleagh House	11·78	299
,,	Lampeter, Falcondale	6·16	157	,,	Enniskillen, Portora...	4·23	107
,,	Cray Station	9·30	236	,,	Crossdoney, Kevit Cas.	4·29	109
,,	B'ham W.W., Tyrmyndd	7·46	189	,,	Armagh Observatory ..	2·97	75
,,	Lake Vyrnwy	8·46	215	,,	Warrenpoint	3·64	93
,,	Llangynhafal, P. Drâw	4·38	111	,,	Belfast, Cave Hill Rd..	3·45	88
,,	Oakley Quarries	..	..	,,	Glenarm Castle	3·47	88
,,	Dolgelly, Bryntirion..	6·80	173	,,	Londonderry, Creggan.	4·00	102
,,	Snowdon L., Llyday 9	25·87	657	,,	Sion Mills	4·47	113
,,	Lligwy	5·43	138	,,	Milford, The Manse ...	4·71	120
XII.	Stoneykirk, Ardwell Ho	2·98	76	,,	Narin, Kiltoorish	7·25	184
,,	Carsphairn, Shiel.....	8·00	203	,,	Killybegs, Rockmount .	7·50	191

Correction—Darrynane Abbey, November, *for* "3·50 | 39," *read* "3·50 | 89."

Climatological Table for the

STATIONS	PRESSURE		TEMPERATURE							
			Absolute				Mean Values			
	Mean of Day M.S.L.	Diff. from Normal	Max.	Date	Min.	Date	Max.	Min.	½ max. and min.	Diff. from Normal
	mb.	mb.	°F.		°F.		°F.	°F.	°F.	°F.
London, Kew Obsy.	1013·3	−2·2	76	21	46	4	66·6	51·7	59·1	−3·6
Gibraltar	1017·6	+2·3	88	8, 31	61	2	81·7	66·7	74·2	−0·5
Malta	1016·0	+2·0	89	16	67	4, 28	82·2	70·8	76·5	−1·0
Sierra Leone	1015·5	+2·1	87	16	72	sev.	82·0	74·0	78·0	−1·0
Lagos, Nigeria	1013·8	0·0	86	30	70	14	81·8	73·1	77·5	+0·2
Kaduna, Nigeria	1012·7	−1·3	83	3	60	26	78·2	66·1	72·1	−2·5
Zomba, Nyasaland	1019·6	+1·7	78	22, 23, 28	48	17	72·7	53·4	63·1	+1·4
Salisbury, Rhodesia	1020·0	−0·9	79	24	34	4	71·5	41·1	56·3	+0·2
Cape Town	1021·8	+0·5	79	12	38	25	63·6	48·4	56·0	+1·1
Johannesburg	1024·6	+0·5	70	31	36	12	63·0	42·5	52·7	+2·1
Mauritius	..	..	..	..	..	..	..	..	..	..
Bloemfontein	..	..	69	27	27	21	63·6	32·3	47·9	+0·6
Calcutta, Alipore Obsy.	998·1	−1·1	93	4	75	27	88·8	79·2	84·0	+0·5
Bombay	1003·4	−0·3	87	10	75	5	83·8	77·3	80·5	−0·6
Madras	1004·1	−0·4	104	6	74	19, 20	97·1	79·0	88·1	+0·8
Colombo, Ceylon	1010·0	+1·9	87	31	71	1, 2	84·7	76·1	80·4	−0·9
Hong Kong	1004·4	−0·5	91	1	73	12	87·3	78·6	82·9	+0·4
Sandakan	..	..	90	3, 25, 29	73	4	88·2	75·4	81·8	−0·1
Sydney	1015·8	−2·7	66	6, 22	39	1	62·0	46·5	54·3	+1·9
Melbourne	1016·4	−2·7	66	31	35	3, 4	57·0	43·0	50·0	+1·4
Adelaide	1017·2	−3·2	68	30	37	25	58·7	44·6	51·7	+0·1
Perth, W. Australia	1017·7	−1·4	68	9	37	15	61·1	45·6	53·3	−1·8
Coolgardie	1019·3	−0·6	69	27	32	15	58·7	39·6	49·1	−2·1
Brisbane	1016·8	−1·5	71	30	39	10	66·5	48·2	57·3	−1·0
Hobart, Tasmania	1016·4	+2·6	60	31	34	3, 25	53·6	41·5	47·5	+2·1
Wellington, N.Z.	1019·5	+6·6	59	11	31	31	54·2	41·8	48·0	+0·5
Suva, Fiji	1014·0	−0·2	85	31	62	26, 28	79·7	67·1	73·4	−0·2
Kingston, Jamaica	1015·6	+0·9	93	12	71	6	90·6	73·6	82·1	+0·4
Grenada, W.I.	1015·2	+1·9	88	31	71	27	83·9	74·3	79·1	+0·2
Toronto	1015·7	+1·6	87	11	50	6	79·9	59·2	69·5	+1·3
Winnipeg	1013·3	+0·6	89	14, 20	41	7	77·7	54·7	66·2	0·0
St. John, N.B.	1016·5	+2·8	77	31	47	10	66·4	53·6	60·0	−0·4
Victoria, B.C.	1018·8	+2·1	87	2	47	30	67·0	50·6	58·8	−1·5

LONDON, KEW OBSERVATORY.—Prevailing wind direction WSW, mean speed 7·9 mi/hr.

GIBRALTAR.—Prevailing wind direction E. Corrected pressure values and diffs. from normal: Mar., 1018·6+2·8, Apr., 1018·7+3·4, May, 1019·0+4·1, June, 1016·6+0·8 mb.

MALTA.—Prevailing wind direction NW.

SIERRA LEONE.—Prevailing wind direction SW, 3 days with thunder heard.

LAGOS, NIGERIA.—Prevailing wind direction SW.

SALISBURY, RHODESIA.—Prevailing wind direction easterly.

MADRAS.—Corrected pressure values and diffs. from normal: Jan., 1013·0, −1·1, Feb. 1012·1, −0·8, Mar., 1010·0, −0·9, Apr., 1007·8, −0·6, May, 1005·0, −0·4, June, 1003·4, −0·5 mb.

Mauritius :—										
January 1922	1007·1	−4·8	89	4	67	2	84·9	73·0	79·0	−0·3
February ,,	1007·0	−4·0	88	23, 24	66	2	85·3	73·0	79·2	−0·1
March ,,	1012·6	+0·6	88	10	69	8, 16	85·5	73·0	79·3	+1·3
April ,,	1013·8	−0·2	88	1	59	30	80·2	68·2	74·2	−1·6

British Empire, July 1922.

TEMPERATURE		Relative Humidity	Mean Cloud Am'nt	PRECIPITATION				BRIGHT SUNSHINE		STATIONS
Mean	Absolute			Amount		Diff. from Normal	Days	Hours per day	Percentage of possible	
Wet Bulb.	Min. on Grass									
°F.	°F.	%	0–10	in.	mm.	mm.				
55·6	36	72	7·3	3·30	84	+ 29	20	4·9	30	London, Kew Obsy.
66·9	58	70	2·4	0·00	0	− 1	0	..	..	Gibraltar.
69·6	64	67	0·3	0·00	0	− 1	0	11·7	82	Malta.
73·8	..	83	8·8	37·68	957	+ 81	29	..	..	Sierra Leone.
73·9	69	79	8·6	2·75	70	− 199	4	..	..	Lagos, Nigeria.
67·6	..	80	1·0	10·35	263	+ 31	14	..	..	Kaduna, Nigeria.
..	..	78	3·5	0·38	10	+ 3	4	..	..	Zomba, Nyasaland.
49·5	..	55	1·5	0·03	1	0	2	..	..	Salisbury, Rhodesia.
52·6	..	78	5·9	2·33	59	− 31	13	..	..	Cape Town.
42·1	28	58	0·6	0·00	0	− 6	0	10·0	94	Johannesburg.
..	..	..	..	..	..	..	..	..	..	Mauritius.
36·4	..	70	2·3	0·00	0	− 10	0	..	..	Bloemfontein.
80·9	74	80	9·1	14·50	368	+ 41	*14	..	..	Calcutta, Alipore Obsy.
77·1	65	84	8·9	31·00	787	+ 148	*30	..	..	Bombay.
76·0	73	59	7·7	3·22	82	− 22	*15	..	..	Madras.
77·0	70	76	9·0	2·71	69	− 61	10	..	..	Colombo, Ceylon.
78·0	..	81	5·8	12·80	325	+ 6	15	8·0	60	Hong Kong.
76·9	..	83	..	5·83	148	− 18	12	..	..	Sandakan.
50·1	26	72	4·3	10·82	275	+ 152	16	5·7	56	Sydney.
47·7	30	78	6·0	2·66	68	+ 22	11	..	..	Melbourne.
47·8	25	76	6·0	4·22	107	+ 40	17	4·4	44	Adelaide.
50·0	30	71	5·8	7·41	188	+ 22	18	5·0	49	Perth, W. Australia.
45·7	26	62	5·2	1·37	35	+ 12	9	..	..	Coolgardie.
53·9	34	69	3·5	4·68	119	+ 63	8	..	..	Brisbane.
44·7	28	82	6·0	6·02	153	+ 99	15	5·1	55	Hobart, Tasmania.
..	19	78	6·0	1·69	43	− 101	12	3·9	41	Wellington, N.Z.
69·1	..	76	6·5	3·79	96	− 21	15	..	..	Suva Fiji.
..	* ..	74	4·4	0·39	10	− 32	1	..	..	Kingston, Jamaica.
74·7	..	77	4·3	7·15	182	− 67	24	..	..	Grenada, W.I.
62·3	47	71	3·7	3·00	76	− 1	11	..	..	Toronto.
60·4	..	70	4·2	4·95	126	+ 49	9	..	..	Winnipeg.
56·9	44	86	6·9	4·07	103	+ 11	13	..	..	St. John, N.B.
53·7	43	80	2·1	Trace	Trace	− 9	1	..	..	Victoria. B.C.

* For Indian Stations a rain day is a day on which 0·1 in. (2·5 mm.) or more rain has fallen.

COLOMBO, CEYLON.—Prevailing wind direction WSW, mean speed 5·8 mi/hr.

HONG KONG.—Prevailing wind direction ESE, mean speed 11·6 mi/hr.; 8 days with thunder heard.

SANDAKAN.—Prevailing wind direction NE.

PERTH, W. AUSTRALIA.—Mean speed of wind 11·9 mi/hr.

WELLINGTON, N.Z.—Prevailing wind direction variable, 3 days with fog.

SUVA, FIJI.—Prevailing wind direction SE.

GRENADA, W.I.—Prevailing wind direction E, 4 days with thunder heard.

										Mauritius:—
75·4	..	85	7·2	33·33	847	+ 650	26	4·9	37	January 1922.
75·0	..	82	6·0	7·37	187	− 26	24	8·4	66	February.
75·0	..	83	5·9	7·49	190	− 48	20	6·7	55	March.
68·5	51	74	4·6	5·56	141	+ 27	17	..	..	April.

(*Continued from p.* 345.)

off the Hebrides and moved slowly north-eastwards, being followed by yet another depression in the Atlantic. An exceptionally strong westerly wind gradient was prevalent over the Atlantic. In the early hours of the 29th the White Star liner *Baltic* reported a storm of force 11 in longitude 29° W.

This last depression crossed England on the 30th, and was situated over southern Scandinavia by the 31st, while a secondary depression moved along the south coasts of the British Isles. On the 29th a rainfall of 81 mm. occured at Lugano.

In northern Europe the weather throughout the month was of a very unsettled character, with frequent falls of snow and sleet. On the 11th, the trawler *Celerina*, after a rough passage from Grimsby, was wrecked in a snowstorm off Vardo.

During the first part of the month a low pressure system over the central Mediterranean caused a period of unsettled weather in this area. On the 10th, 43 mm. of rain fell at Malta. About the middle of the month a high over the Western Mediterranean gave fair weather for a few days but afterwards a low, forming in a westerly current, persisted and gave unsettled weather for the remainder of the month.

W.C.K.

The month was cold and stormy on the Great Lakes; on the 18th it was reported that ice was already forming at the head of Lake Superior.

In Australia good rains were experienced, especially in central Queensland, where a good cotton crop is anticipated in consequence, and in many parts of New South Wales.

The special message from Brazil states that in the north rain was 45 mm. below the normal, while in the south, where atmospheric circulation was again very active, it was 54 mm. above normal. The rains in the centre were irregular. Temperature during the month was slightly above normal and pressure at Rio de Janeiro 1·8 mb. above normal. Thunderstorms were rare. The coffee and cotton crops are very promising, but in the south, wheat has suffered severely from rust.

Rainfall in the British Isles.

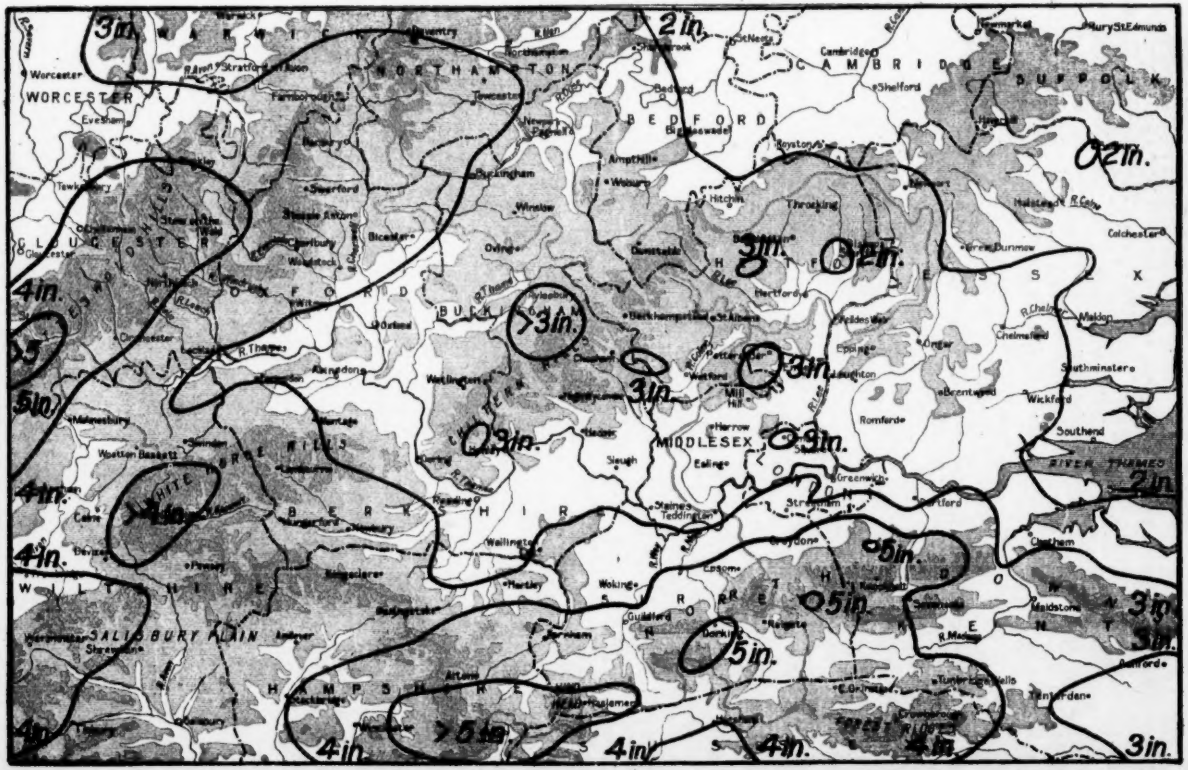
THE general rainfall over the British Isles for December was practically normal. Almost the whole of England and Wales and Ireland had more than the average, while in Scotland there was a widespread but not very large deficiency. Departures of more than 50 per cent. from the average were rare and occurred chiefly in a wet patch in the centre of Yorkshire.

The general rainfall, expressed as a percentage of the average, was :—England and Wales, 122; Scotland, 86; Ireland, 102; British Isles, 106.

In London, Camden Square, the mean temperature for December was 43·4° F., or 3·3° F. above the average. Duration of rainfall, 57·0 hours. Evaporation, 0·14 inch.

THAMES VALLEY RAINFALL —— DECEMBER, 1922.

THAMES VALLEY RAINFALL —— DECEMBER, 1922.



Watershed of River Thames above Teddington and River Lee above Feildon Weir —— Isohyetals.

H.M. Stationery Office Press, Kingsway W.C.2.

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